Harry Freeman

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EDUCATION

Carnegie Mellon University, School of Computer Science, Pittsburgh, PA   Expected August 2023
Master of Science in Robotics
Cumulative GPA: 4.25

Cornell University, College of Engineering, Ithaca, NY   Awarded May 2017
Bachelor of Science in Electrical and Computer Engineering
Cumulative GPA: 3.73

PUBLICATIONS

Under Review

- **Apple Fruitlet Sizing and Growth Rate Tracking with Computer Vision**
  Harry Freeman, Mohamad Qadri, Abhisesh Silwal, Paul O'Connor, Zachary Rubinstein,
  Daniel Cooley, George Kantor
  Submitted to IEEE Transactions on Robotics (T-RO)
  [Preprint][Video]

- **3D Reconstruction-Based Seed Counting for Sorghum Pannicles for Agricultural Inspection**
  Harry Freeman, Eric Schneider, Chung Hee Kim, Moonyoung Lee, George Kantor
  Submitted to IEEE International Conference on Robotics and Automation (ICRA), 2023
  [Preprint][Video]

- **Towards Autonomous Apple Fruitlet Sizing with Next Best View Planning**
  Harry Freeman
  Submitted to AI for Agriculture and Food Systems (AAIFS), 2023
  [Preprint]

Peer-Reviewed Conferences

- **3D Human Reconstruction in the Wild with Collaborative Aerial Cameras**
  Cherie Ho, Andrew Jong, **Harry Freeman**, Rohan Rao, Rogerio Bonatti, Sebastian Scherer
  International Conference of Intelligent Robots and Systems (IROS), 2021
  [PDF][Video]

Workshops

- **Toward Semantic Scene Understanding for Fine-Grained 3D Modeling of Plants**
  Mohamad Qadri, **Harry Freeman**, Franz Eric Schneider, George Kantor
  AI for Agriculture and Food Systems (AAIFS), 2022
  [PDF][Video]

RESEARCH EXPERIENCE

Agricultural Systems Lab - Carnegie Mellon University, Pittsburgh, PA   August 2021 – Present
- Successfully created a method to construct high-quality 3D models of Sorghum Pannicles. Approach utilized RAFT-Stereo, Mask -RCNN, seeds as semantic features in both 2D and 3D, and a novel density clustering algorithm. Results demonstrated improved 3D reconstructions and more accurate seed counts compared to state-of-the-art methods.
- Built a real-time ROS-based computer vision application to size apple fruitlets in the field. Approach includes RAFT-Stereo, Faster-RCNN, Pix2Pix, and ellipse-fitting.
- Successfully utilized Graph-Attention-Networks for cross-day fruitlet association in order to fully automate fruitlet tracking and abscise prediction.

- Currently researching reinforcement learning-based approaches for Next Best View Planning in the field to allow robots to capture more intelligent images of apple fruitlets for sizing purposes.

AirLab - Carnegie Mellon University, Pittsburgh, PA   August 2020 – August 2021
- Assisted PhD student Cherie Ho on multi-drone collaboration for 3D human reconstruction
- Working on multi-robot visual tracking, utilizing Kalman filters to fuse raycasted position estimates from multiple robots tracking the same target
- Built 3D reconstruction post-processing pipeline, integrating AlphaPose and 3D multi-view reconstruction algorithms into ROS to extract 3D skeleton pose from multi-view aerial footage of actor
- Modified AirSim and Unreal open-source code to extract ground-truth skeletal mesh and bone positions of actor. To be used for simulation analysis in IROS paper
- Integrated and test OpenVINO with ROS for real-time person detection to run on Intel NUC

Technology for Avian Birds and Environmental Research - Cornell University, Ithaca, NY   August 2016 – May 2017
- Assisted professors in researching, configuring, and programming small, low-powered, transponding tags to be used to study the migration patterns of birds using Si1060 microcontroller
- Investigated the effects of implementing different data modulation schemes, evaluating power consumption, signal integrity, susceptibility to interference, and data loss.
- Improved average power consumption by configuring microcontroller low-power mode operations
- Results of work deployed to study flight patterns of barn swallows migrating from California to Argentina

RELEVANT MASTER'S COURSEWORK

Deep Learning for Robotics	Learning for 3D Vision	Computer Vision
Statistical Techniques in Robotics	Learning-based Image Synthesis	Math Fundamentals for Robotics

RELEVANT ONLINE COURSEWORK

Reinforcement Learning (U)	Artificial Intelligence for Robotics (U)	Deep Learning Specialization (C)
U – courses taken through Udacity	C – courses taken through Coursera	

WORK EXPERIENCE

Amazon AWS AI Devices Palo Alto, CA   August 2020 – August 2021
Senior Software Development Engineer
- Senior Engineer on AWS Panorama – a machine learning appliance that allows IP cameras to run computer vision and deep learning applications at the edge
- Developed multi-threaded and multi-process application level software, supporting the full lifecycle of allowing customers to deploy and run their custom applications
- Lead the design and development of the entitlement and encryption service, a service which utilizes MQTT to communicate with the cloud and securely manages the IP of 1P and 3P applications
- Lead the design and development of the data source service, allowing customers to stream data from RTSP cameras and video files in real time

Eversight Palo Alto, CA   July 2019 – August 2020
Software Engineer
- Contributed to building large scale reinforcement learning networks to optimize prices in consumer-good retail stores
- Improved optimal price generation time by 80% by re-designing backend container-driven system architecture using Kubernetes and Google Cloud Platform that could effectively scale and process resource heavy tasks, including processing millions of transaction records daily and optimizing in-store prices using customer data
- Lead the architecture design that loaded customer data into our system using a scalable event driven architecture and Apache Beam, reducing the time of the overall process by 50%
- Improved optimal price recommendations by developing an algorithm to detect undisclosed in-store promotions from customer data

Edelman Financial Engines Sunnyvale, CA   April 2018 – July 2019
Senior Software Engineer
- Developed an online financial planning tool to provide a new medium for financial advisors to offer financial advice
- Increased the number of customers on our platform by 200% by leading the design of a new microservice utilizing AWS to automate the migration of customer data form competitor's service to our platform
- Implemented and integrated financial algorithms that utilized Monte Carlo Simulations and additional features into the product in order to allow the user to visualize and modify their estimated portfolio performance

Macdonald, Dettwiler, and Associates, Vancouver, BC   August 2017 – March 2018
Embedded Software Engineer
- Acted as part of a small research and development team whose goal was to determine the feasibility and performance of implementing SAR image processing algorithms on FPGAs for real-time sea-vessel detection and classification
- Improved SAR image processing time by three orders of magnitude by successfully constructed embedded RTL designs in C and VHDL to implement SAR signal processing algorithms, reducing the overall processing time from seconds to milliseconds

PROJECTS
Graduate
- *In Progress:* Applying deep reinforcement learning techniques to learn a unified policy to control a quadruped mounted with a mobile arm with the task of tracking a moving target. The hypothesis is that this configuration will enable the robot to explore more complex terrains when compared to using a fixed egocentric camera. Agent is trained using PPO and advantage mixing in Isaac Gym simulation environment to take advantage of parallelized processing.

- *In Progress:* Applying deep reinforcement learning techniques towards informative path planning for drone mapping. Agent is learning an optimal policy to intelligently explore an unknown map to visit areas of high interest. Experimenting with both on-policy and off-policy approaches in addition to model-based and model-free algorithms.

- Utilized NeuS to create accurate, watertight meshes of plants from sparse 2D images. Models were made generalizable by incorporate Reptil meta-learning into training. Results demonstrate the meta-learning improves reconstructions with fewer training iterations, and are approach is able to generate realistic meshes and novel view synthesis with sparser 2D images compared to naïve approaches.
  [Project Writeup] [Data Repo] [Code Repo]

- Utilized Generative-Adversarial Networks for coarse style and scene data augmentation. Method was based off Swapping AutoEncoders. Results successfully demonstrated that swapping latent style codes is effective approach for data augmentation to allow models to better generalize and not overfit the training data.
  [Project Webpage] [Code Repo]

Undergraduate
- Built an iOS controlled massage vest that allowed the user to create a custom massage by controlling the pattern, region, and intensity over Bluetooth. Designed both the hardware-control system and multi-threaded software. Published article in *Circuit Cella.r* Issue 330. Massage Vest Uses PIC32 – Controlled with an iOS App
  [Project Webpage]

- Built a competition-winning arduino-based autonomous maze-mapping robot that could self-navigate and map a maze to be displayed on a remote video-base station. Achieved the lowest-average navigation time with no obstacle collision

Personal
- Built a real-time face detection system in Cython and C using variation of Histogram of Oriented Gradients. SVM was trained using LFW dataset, and overlapping bounding boxes are reduced using non-maximum suppression.
  [Project Webpage] [GitHub Repo]

- Built scale and rotation invariant keypoint descriptor in Matlab based of Lowe's SIFT algorithm. Dictionary was built using Home Objects Dataset.
  [GitHub Repo]

- Built a voice-recorder using PIC32 that could record audio and playback with adjustable sampling rate. Utilized internal ADC, DMA, PWM and flash storage with external microphone and amplifier
  [GitHub Repo]
- Built a quaternion and complementary-filter based system to accurately track orientation of MPU9255 which was used to control a mouse. Orientation was implemented from scratch without use of Digital Motion Processor
  [GitHub Repo]
- Designed a system to control television over Bluetooth from phone using ATMega2560 microcontroller
  [GitHub Repo]
- Built a multi-radio network using NRF24 transceivers to track and analyze squash/tennis movement patterns that can be controlled via Bluetooth from iOS
  [GitHub Repo]

SKILLS

Programming Languages	C++, C, Python, Java, Matlab, VHDL, SQL
Robotics	ROS, Gazebo, MoveIt, AirSim
Software	Docker, Isaac Gym, PyTorch, GCP, AWS, Kubernetes
Hardware	Oscilloscope, Spectrum Analyzer, Logic Analyzer, Microcontrollers

OTHER ACTIVITIES

Cornell Varisty Squash Team   August 2013 – May 2017
- Competed on the Cornell Varsity Squash Team. Trained, travelled, and competed six days a week
- Captained the team my Senior year. Lead and managed the team alongside the coach
- Played at the number one position Junior and Senior years
- CSA Scholar Athlete Junior and Senior years
- Three-time recipient of team sportsmanship award
- Two-time recipient of team most improved award

Matlab Consultant   August 2014 – December 2014
- Acted as a consultant for the Introduction to Matlab course
- Ran labs and discussions. Worked through exercises with students and provided supplemental information
- Held office hours to answer student questions regarding material, exam preparation, and lab assignments
- Graded assignments and exams